Revision Log

Revisions to the Rearticulated Science Standards Adopted by the State Board of Education proposed by Michael A. Clarke Ph.D. and Terry L. Hufford Ph.D.

May 17, 2010

Revisions to the Rearticulated Grade 5 Science Standards		
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Preamble	Addition of "and drawing appropriate inferences based on those investigations."	The Scientific process, often depicted as having four (4) steps [Observation, Hypothesis Formulation, Prediction, and Experimentation] should be more accurately depicted as having five (5) steps as the Experimentation step and the use of the experimental data to either support, modify, or reject the hypothesis should be identified as separate steps. The process does not end with collecting the experimental results but it continues with the use of those results and may become iterative as the search for valid explanations continue.
Preamble	Addition of "methodology… and data."	Science inquiry requires reproducibility for data validity. An important aspect of reproducibility is the accurate record of the methodology employ and all data collected. These concepts should be stressed as part of any effort to create scientific thinkers.
Preamble: Students should observe (a)	Re-written as "Stars, planets, satellites, and other celestial bodies by either visiting an observatory or a planetarium. Discussion of observable peculiarities and characteristics should be encouraged."	The original observations identified are not usually possible in the night sky of urban environments and therefore guidance on a more appropriate approach to this activity is given (planetarium or observatory visits). Students should not be led to believe that all apparently luminescent celestial bodies are Stars. Students should appreciate that some celestial bodies generate light while others simply reflect light. It is important that students are made aware of the variety of celestial bodies and that students are aware that some of these celestial bodies are man made satellites.
Preamble:	Re-written as "Some organisms,	The original language had a teleological bent which presupposes that the organism

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Students should observe (b)	consisting of a single cell, interacting with the environment in various ways."	selects the environment because of its attributes. In reality organisms find themselves in all types of environments generating all types of interactions which may have summative positive of negative effects on the organism's ability to survive in that environment.
Preamble: Students should observe (c)	Re-written as "Some organisms are made of a collection of cells that interact with each other in various ways."	It is misleading to suggest that multicellular organisms are made of a collection of "similar cells" as it is obvious that specialized cells can only have limited similarity. It is also incorrect to assume that all cells benefit from cooperation in a multicellular organism. More neutral language respecting the divergence of possibilities has been employed.
Preamble: Students should investigate (a)	Re-written as "That when liquid water evaporates, it turns into a gas (vapor) mixed into the air, and upon cooling can condense and reappear as a liquid. When cooled below its freezing point it appears as a solid (ice). [No explicit treatment of sublimation is required at this level.]"	The statement has been rewritten to emphasize that it is cooling that causes condensation. Further direction is added which acknowledges the phenomenon of sublimation so that teachers and students are not misled into believing that the model presented is complete, there is more to be learned at a latter stage.
Preamble: Students should investigate (c)	Addition of " [Examples using ice and hot water in insulated and non-insulated cups at room temperature monitoring time for melting or temperature changes would be experimentally appropriate.]"	Guidance for teachers was added as 5th grade teachers are not usually Science Specialists and therefore additional guidance as to what might be appropriate is necessary.
Preamble:	Addition of "[For example	Guidance for teachers was added as 5th grade teachers are not usually Science

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Students should investigate (d)	students should have the opportunity to use spring balances to investigate the effects of balanced and unbalanced tensions applied to inanimate objects.]"	Specialists and therefore additional guidance as to what might be appropriate is necessary.
Preamble: Students should investigate (e)	Addition of "[Familiarity and play with bat and ball games can be used to enhance this concept.]"	Guidance for teachers was added as 5th grade teachers are not usually Science Specialists and therefore additional guidance as to what might be appropriate is necessary.
Indicator 5.1.2.	Change "about the past" to "from other experimentation"	Language has been recast for greater precision in meaning.
Indicator 5.1.3.	Change "for statistical accuracy" to "and how statistical evaluations may inform that accuracy."	Language has been recast for greater precision in meaning.
Indicator 5.1.4.	Change "from linear dimensions, using" to "by covering areas with unit squares, filling volumes with unit cubes, and then making comparisons using linear dimensions and the"	The original standard did not connect the mathematical to the experimental and therefore appeared more as a mathematical standard-statement than a science standard-statement.
Standard 2	Change "in a Scientific context" to "in the context of a Scientific inquiry."	Language has been recast for greater precision in meaning.
Indicator 5.2.1.	Addition of "differences or"	Different methods, materials, or observation protocols may inherently give rise to different systematic errors leading to different results. This type of error is conceptually different from the random experimental errors associated with

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		inconsistencies.
Indicator 5.2.4.	Addition of "techniques or engaging in new"	Students do not 'learn' investigations. They 'learn' techniques but they 'engage' in investigations. This is part of the bigger discussion of 'laboratory experiments' versus 'laboratory experiences.'
Indicator 5.2.6.	Addition of "if known errors in methodology or observations exist."	The influence of the scientist's bias on the outcome of an experiment is often cited as one of the common mistakes in the application of the scientific method. The main mechanism for bias to impact experimental outcomes is by the scientist ignoring or ruling out data which is not consistent with a particular bias. Data should only be ruled out if it is known that a mistake was made in the collection of the data. Otherwise all resultant data should be reported and used in examining the hypothesis being tested.
Standard 3	Addition of "used in their everyday lives" and "where appropriate"	The fact that technology is embedded in many inextricable ways with our modern lives allows teachers to connect the classroom to real life. Sometimes these applications are overlooked if not explicitly stated. The appropriate use of technology should also be addressed. Too often in our zeal to incorporate technology into education it is incorporated in inappropriate and ineffective ways.
Indicator 5.3.1.	Replace "observe things that are too small or too far away to be seen without them and to study the motion of objects that are moving too rapidly or are hardly moving" with "gather data and to make observations that would be impossible or impractical with the unaided senses."	The broader statement, which is more accurate, is more appropriate as the more narrow statement previously employed may be subject to interpretation by students and teachers of being a limiting or exhaustive list of applicable situations.
Indicator 5.7.1.	Change "to form" to "forming"	Moving away from teleological language; the atoms have no intent to do anything, what happens when atoms combine forming molecules is simply a consequence of

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		physical laws of interaction.
Indicators 5.7.3.and 5.7.4.	A new indicator 5.7.3 has been added and the old 5.7.3 has be renumbered as 5.7.4	Students are asked to use the concepts of element, compound, atom, and molecule in explanations of the composition of matter (5.7.4) without these concepts being properly introduced and related. This is an example of an incomplete learning progression and any attempt at assessment of 5.7.4 which shows a lack of understanding would be useless diagnostically. It would be impossible to distinguish which part of the learning progression has not been mastered by the students and the reports would have no instructional utility.
Indicator 5.8.2	Replace "that many kinds of chemical changes occur faster at higher temperatures" with "the effect of temperature on the rate of chemical changes (reactions). [The use of refrigeration in slowing decay process is readily available example]."	The original example is one specific example of a broader physical phenomenon. It is more beneficial for students to grasp the full phenomenon and, with the example supplied; it provides another example of technology in our everyday lives.
Standard 10	Replace "sub-unit" with "unit entity"	Conceptually more accurate.
Indicator 5.10.1	Rewrite	The original was not clear and was written from a teleological perspective.
Indicator 5.10.2	Rewrite	It is misleading to suggest that multicellular organisms are made of a collection of "similar cells" as it is obvious that specialized cells can only have limited similarity. It is also incorrect to assume that all cells benefit from cooperation in a multicellular organism. More neutral language respecting the divergence of possibilities has been employed.
Indicator 5.11.1	Replace "in order for offspring to resemble their parents" with "for	The language of the original indicator promotes a misconception that leads to student confusion as many students realize that sometimes offspring resemble one

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	an offspring to obtain genetic information from each parent. This may result in the offspring having characteristics which resemble those of one of the parents, both parents, or neither parent."	parent, or the other, or both parents, or neither parent.
Indicator 5.11.2	Rewrite	This is part of the genotype-phenotype discussion. There is no inherited characteristic that is totally immune from environmental effects so the portrayal of genotype-phenotype as a dichotomy reinforces a prevalent misconception among students of the biological sciences.
Indicator 5.12.2	Rewrite	Non-native invasive species bring with them attributes which enhance their reproductive and survival rates. The suggestion that they adapt to increase their chances of survival is a teleological argument without a scientific basis.
Indicator 5.12.3	Rewrite	The deliberate impact of humans on their environment and the scale and longevity of this impact are sufficiently distinctive that it is inappropriate to categorize the impact of all organisms on their environments as examples of the same phenomenon.
Indicator 5.12.4	Rewrite	Natural selection is a statistical not a teleological phenomenon. It is not intent in reproduction but statistical variability within populations that enhance survival rates.
Indicator 5.12.6	Replace "seasonal behaviors" with "certain physiological, structural, or behavioral differences"	Survival in harsh environments depends on more that just seasonal behaviors, the original language reinforces a common misconception.
Indicator 5.12.7	Addition of "[not learned]"	Clarifies the meaning of instinctive.
Indicator 5.12.8	Replace "in response to" with "as a consequence of"	"In response to" suggests some level of anthropomorphism as if the plant can think about the phenomenon and respond to it whereas 'as a consequence of' is more

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		neutral, describing a more inert action.
Indicator 5.12.9	Rewrite	Fossils do not readily provide information it is only through diligent detective work that information can be decoded from fossils. It is important that students understand how information is derived in the scientific world if they are to become scientists.

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Preamble	Addition of "and drawing appropriate inferences based on observations and evidence" and ", and suggest appropriate inferences based on those investigations."	The Scientific process, often depicted as having four (4) steps [Observation, Hypothesis Formulation, Prediction, and Experimentation] should be more accurately depicted as having five (5) steps as the Experimentation step and the use of the experimental data to either support, modify, or reject the hypothesis should be identified as separate steps. The process does not end with collecting the experimental results but it continues with the use of those results and may become iterative as the search for valid explanations continue.
Preamble	Addition of "and interpretation of content."	At 8th grade students should be encouraged to relate science to the world around them, content should not simply be memorized or learned but should be interpreted in the context of their experiences.
Preamble: Students should discover (a)	Replace "to form" with "forming"	Teleological correction. Reactants have no intentions when they come into contact; the result is simply a consequence of all possible interactions.
Indicator 8.1.3	Addition of "based on available evidence [emphasizing the importance of evidence over opinion for scientific reasoning]."	This guidance is important as we seek to develop scientific thinking skills. Science as a way of think rather than a collection of thoughts.

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Indicator 8.1.4	Rewrite and itemize the common fallacies	This structure offers greater clarity to teachers, students, and parents
Indicator 8.2.1	Rewrite	Greater clarity
Indicator 8.2.3	Addition of "and describe what can be inferred from the graphs and illustrations."	The ability to draw inferences from graphs and illustrations is explicitly stated to ensure that teachers address these skills.
Indicator 8.3.2	Change "and know that the atom is composed of protons, neutrons, and electrons" to "showing the atom is composed of protons, neutrons, and electrons. No knowledge of other subatomic particles is required at this grade level."	It is important that the student diagram demonstrates this knowledge and that all students are aware that even though these are the only subatomic particles studied at this level they are not the only subatomic particles that exist.
Indicator 8.3.3	Replace "electrically charged either positively or negatively; objects with like charges repel each other, or objects with unlike charges attract each other" with "neutral (e.g., atom) or electrically charged (e.g., ion) having either a positive or negative charge. **8.3.4.** Demonstrate that objects with like charges repel each other and objects with unlike charges attract each other."	There are actually three electrical states; neutral, positive, and negative. This rephrasing corrects a potential misconception. The concept of charge interactions should be treated as a separate idea and measured via a separate indicator so a new indicator 8.3.4 was added with this idea.
Indicator 8.3.5	Addition of a new indicator.	Addresses the idea of isotopes completing the learning progression on atomic structure as a part of Standards 3, the Structure of Matter.

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Indicators 8.3.4; 8.3.5; 8.3.6	Renumbered as 8.3.6; 8.3.7; 8.3.8	The creation of new indicators 8.3.4, and 8.3.5 created the need renumbering.
Standard 4	Change "toll" to "tool"	Correcting a typographical error.
Indicator 8.4.1	Rewrite	Greater clarity on the use of the periodic table.
Indicator 8.5.2	Replace "to produce" with "producing"	Teleological correction.
Indicator 8.5.3	Rewrite	Clarify the electrical nature of covalent and ionic bonding
Indicator 8.5.2	Replace "to form" with "forming"	Teleological correction.

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Preamble	Replace "Evaluation" with "Evolution"	Correcting a typographical error.
Preamble	Addition of "Where examples are listed it is not intended that these are exhaustive lists but should only be viewed as lists of exemplars to which teachers may add additional examples."	Clarification of the function of exemplars added to the text
Preamble	Addition of "and drawing appropriate inferences based on	The Scientific process, often depicted as having four (4) steps [Observation, Hypothesis Formulation, Prediction, and Experimentation] should be more

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	observations and evidence" and ", and suggest appropriate inferences based on those investigations."	accurately depicted as having five (5) steps as the Experimentation step and the use of the experimental data to either support, modify, or reject the hypothesis should be identified as separate steps. The process does not end with collecting the experimental results but it continues with the use of those results and may become iterative as the search for valid explanations continue.
Preamble; 'students should: 1'	Rewrite	Clarify the elements of scientific methodology.
Preamble; 'students should: 2'	Addition of "in scientific investigations" and change "conditions" to "variables"	Enhance clarity by defining the context and using more precise terms.
Preamble; 'students should: 5'	Change "new" to "biological"; "check on" to "verify"; "verify or falsify the prediction of a theory" to "test predictions based on theories"; delete "to use a crucial experiment"	Enhance clarity by defining the context and using more precise terms.
Preamble; 'students should: 6'	Rewrite	The concept of experimental design as a precursor to data selection and collection was added.
Preamble; 'students should: 7'	Change "conditions" to "variables": Addition of "Students and instructors should be cautioned that variability is an important characteristic of natural populations and seemingly discrepant data points may be	Enhanced clarity and management of experimenter bias.

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	valid data points that are outliers [at either extreme of the distribution]."	
Preamble; 'students should: 10'	Addition of "and statistical"	The importance of statistics in the evolution of many classical theories requires that student understand statistical models and modeling.
Preamble; 'students should: 11'	Addition of "fossil containing"	Enhanced clarity and specificity
Preamble; 'students should: 12'	Rewrite	Enhanced clarity and specificity
Standard 1	Replace "to form" with "forming"	Teleological correction
Indicator B.2.2	Rewrite	Recognizes the current three domain classification system of Biology which has replaced the older five kingdom system.
Indicator B.2.3	Replace "selective" with "differentially"; "diffusion" with "diffusive mechanisms"	More in line with current thinking.
Indicator B.2.4	Delete "eukaryotic"; and rewrite	Recognition that all photosynthesizing organisms are not necessarily plants and ensuring the accuracy of concepts.
Indicator B.2.5	Addition of "biochemical activities taking place in the organism resulting in"	More correct causality statement
Indicator B.2.6	Replace "required" with "inherent"; "to" with "and": Addition of "and within cells"	Teleological corrections and the acknowledgement that communication not only occurs between cells but also within cells.

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Indicator B.3.4	Replace "cause' with "result in"	Teleological correction
Indicator B.3.6	Rewrite	Corrects the misconception that photosynthesis occurs only in the leaves of plants and refines the concept of 'food'
Indicator B.3.7	Rewrite	Clarifies that cellular respiration is only part of the process of ATP production.
Indicator B.4.1	Addition of "tissue systems (in plants)" and "(in animals)"	Completes the list and adds necessary contexts.
Indicator B.4.2	Replace "for" with "involved in"	Indicates that there are other entities that may be involved in the activities cited and students should not assume that the specialized parts studied are the only parts involved in these activities.
Indicator B.4.3	Addition of "and peroxysomes" and "a central vacuole, and glyoxysomes and only animal cells have lysosomes"	Updated and completed lists.
Indicator B.4.4	Replace "it assembles" with "assemble biochemical compounds"	Enhanced clarity and specificity
Indicator B.5.2	New indicator	Adds more body and context to a thinly defined concept.
Indicator B.6.1	Rewrite	Imposition of the modern gene concept on the interpretation of Mendel's laws creates and enhances misconceptions surrounding the logical versus physical structures associated with inheritance.
Indicator B.6.2	Change "often" to "may"	Research has shown that these systems often do not match and statements that they often do support a coherence of genetic and inheritance theories that has no basis in reality.
Indicator B.6.3	Change "of genes" to "associated with DNA and RNA"	Gens are a valid logical construct; however there is no directly analogous physical construct. Use of genes in this way promotes a misconception that is best addressed

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		by avoiding confusion of logical constructs and physical constructs in combinations referencing actions which speak to physical behaviors or interactions. Hence replacing genes with references to DNA and RNA which are physical constructs creates a more pedagogically sound and coherent idea for the indicator.
Indicator B.6.5	Rewrite	Creates confusion by linking ideas that are not intrinsically connected and so can reinforce misconceptions. Rewritten for enhanced clarity and specificity.
Standard 7	Rewrite	We now know that the logical construct of a Gene does not correspond to "a set of instructions encoded in the DNA sequence." This standard was rewritten to remove the incorrect information and recast the idea in a manner more consistent with current understanding.
Indicators B.7.1 and B.7.2	New indicators addressing the ideas formerly embedded in B.7.2	Needed to address fully chromosomal and non-chromosomal transfer of hereditary information. This examines the physical constructs that underlie the logical constructs referred to as Genes.
Indicators B.7.1 through B.7.6	Renumbered as B.7.3 through B.7.7	[B.7.1 = B.7.3]; [B.7.3 = B.7.4]; [B.7.4 = B.7.5]; [B.7.5 = B.7.6]; [B.7.6 = B.7.7];
Indicator B.7.6	Replace "usual" with "original"	Usual in this context can be ambiguous but original is a more precise term, less open to misinterpretation.
Standard 8	Replace "Genes" with "DNA"; also replace "Genes specify" with "DNA generally specifies"	Since Genes are a logical rather than a physical construct it would be more appropriate to talk about the Structure and Function of DNA which is a physical entity than the Structure and Function of Genes.
Indicator B.8.1	Addition of "how"	Clarity
Indicator B.8.2	Addition of "DNA"	Correctness
Standard 9	Addition of "within a population"	Completeness, clarity, and correctness

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Indicator B.9.1	Addition of "[a physical construct] may … [a logical construct]."	Supplies clarity as the student is being asked to connect logical and physical constructs and their possible relationships to each other.
Indicator B.9.3	Replace "Genes" with "genetic sequences"	While physical sections of DNA cannot be identified as genes the use of the term genetic sequence in this instance can be effective in developing the concept or diversity in alleles without supporting common misconceptions.
Indicator B.9.4	Addition of "transposition" also replace "Genes" with "genetic sequences"	Introduces students to the correct technical term and addresses the same issues identified by the changes to Indicator B.9.3 above.
Standard 10	Replace "Theory of Evolution" with "Scientific Theories of the Origin of Life and the Evolution of Living Forms"	It is incorrect to suggest that there is only one "Theory of Evolution" which is often taken to include a theory of the Origin of Life. It is important that students are exposed to multiple Scientific theories of the origin of life and the evolution of life forms. It is also important that students engage in discussion as to the strengths and weaknesses of these theories.
Indicator B.10.1	Insert "or more" and "or so"; replace "could evolve" with "evolved"	Accuracy and clarity
Indicator B.10.2	Rewrite	As originally stated the original indicator reinforced the misconception that Charles Darwin was the originator of the ideas about evolution and it ignores the work of Leclerc, Buffon, Lamarck, and Erasmus Darwin. It is important that students are aware of how this train of though developed, building on the work of the precursors as other ideas in science have also developed.
Indicator B.10.3	Rewrite	Accuracy, clarity, and completeness
Indicator B.10.4	Rewrite	Accuracy, clarity, and completeness
Standard 11	Rewrite	Accuracy

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Indicator B.11.1	New indicator	Introduces the statistical perspective of diversity within a population and the impact on survivability
Indicators B.11.1, B.11.2, B.11.3	Renumbered B.11.2, B.11.3, B.11.4	Consistency of numbering
Indicator B.11.3	Delete "optimally"	Unfounded judgment
Indicator B.11.4	Rewrite	Accuracy and completeness
Indicator B.12.2	Rewrite	Knowing recondite facts is useless. The importance of being aware of the diversity of a particular life form is in relating that diversity to the diversity of other interacting life forms and thereby grasping the concept to interconnect systems of diverse life forms and the ecosystems that they create.
Indicator B.12.3	Rewrite	Accuracy and completeness
Indicator B.12.4	Rewrite	The original statement trivializes the numerous mechanisms that have evolved in plants to respond to unpredictable or unfavorable environments. This indicator was rewritten for accuracy, clarity, and completeness.
Indicator B.13.1	Rewrite	Accuracy, clarity, and completeness.
Indicator B.13.2	Replace "to ensure" with "ensuring". Rewrite remainder of indicator	Teleological correction and a rewrite to achieve accuracy, clarity, and completeness.
Standard 14	Rewrite	Clarity
Indicator	Insert "Consider and"	Reflective practice as part of academic engagement is important especially as

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14.1		students consider the mammalian body systems which will inform them of how their own bodies function and a biological (anatomical) level.
Standard 15	Change "be introduced to" to "consider the significance of"	As students examine phenomenon linked strongly to their own existence and functioning, it is not sufficient to 'learn' science but it becomes important to reflect on how that science directly impacts their own lives. It is important to consider the significance of the phenomena they encounter.
Indicator B.15.3	Replace "optimal" with "functional"	Accuracy. The myth that bodies are always functioning at optimal capacity should not be reinforced when the reality is obvious to every student who has ever been ill.
Indicator B.15.4	Replace "to protect" with "such that it protects"	Teleological correction.
Standard 16	Insert "Ecological"	Specificity
Indicator B.16.1	Replace "and differences" with "[commonalities and differences]"	Clarity
Indicator B.17.1	Replace "the cycles of" with "both cyclic and non-cyclic"; replace "in" with "of"	Accuracy, clarity, and completeness
Indicator B.17.2	Replace "energy" with "food"	Accuracy and specificity
Indicator B.17.3	Replace "to analyze the effects" with "the effect of that impact can be analyzed."	Accuracy and specificity
Standard 18	Rewrite	Accuracy, clarity, and completeness
Indicator B.18.2	Replace "non-native" with "invasive"	More specific to an ecological problem with many recent and relevant examples in the DC Metropolitan area. Relates Science to everyday life and current events in the local news.

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Indicator B.19.1	Insert "Consider the differences between point and non-point source pollution"	Reinforcing reflective practice in examining the significance of science.